

Protection from

Oak Wilt

with MACRO-INFUSION™



- Macro-Infusion™ with Alamo® is recommended by the US Forest Service, Texas Forest Service, Texas A&M, University of Minnesota and the other major universities.
- Protection from root graft transmission in Red & Live Oak families (93% success)
- Curative treatment from Oak Wilt for trees in the White Oak family (99% success)
- Used by leading arborist companies such as Davey Tree, Bartlett Tree Experts and Care of Trees.



Alamo® is a systemic fungicide to be used for prevention and treatment of Oak Wilt by trained arborists and others trained in Macro-Infusion™ techniques.



Protection from
Oak Wilt
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Oak Wilt

Technical Description

Oak Wilt is a Fungus

Oak Wilt is a lethal vascular disease that is caused by the fungus *Ceratocystis fagacearum*. The fungus lives and grows in the current year's xylem and all families of oaks are susceptible. This disease is often misdiagnosed. Oaks attempt to stop the spread of the fungus by producing gummy substances called tyloses. The combination of the fungus and tyloses disrupts the flow of water to the canopy and contributes to the leaf wilting and drop associated with Oak Wilt.

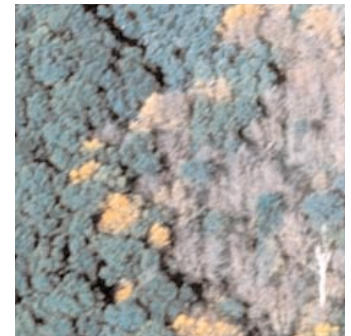
Diagnosing Oak Wilt

Diagnosing Oak Wilt begins with observing foliar symptoms, patterns of tree mortality, and the presence of fungal mats. Foliar symptoms are a great indicator, but are only present during certain times of the year. Patterns of tree mortality can be viewed any time of the year and will give a good indication of disease presence. A good way of diagnosing Oak Wilt is to look around first. If you see odd patterns of tree loss in an area, you may find the progression of Oak Wilt. Fungal mats form on **Red Oaks** in the spring and are great indicators when found. The fungus produces pressure pads between the bark and the wood, which cracks the bark open and emits a fruity odor.

Leaf Symptoms

Leaf symptoms on Live Oaks are easily noticeable. Leaves will develop a yellowing and eventual browning of the veins, which is called veinal necrosis. **Red Oaks** will often turn pale green and then brown. It is common to find partially dying leaves, of both **Live Oaks** and **Red Oaks**, lying underneath a tree. Unlike **Live Oaks** symptoms on **Red** and **White Oaks** progress from the outside margins to the inner leaf.

Sapwood streaking beneath the bark is a diagnostic indicator of infection in the red and **White Oak** families. This brownish discoloration may not always be apparent, however, but even if it is not seen, Oak Wilt may still be present.

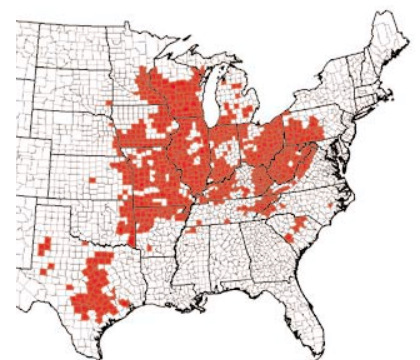


Oak Wilt infection center

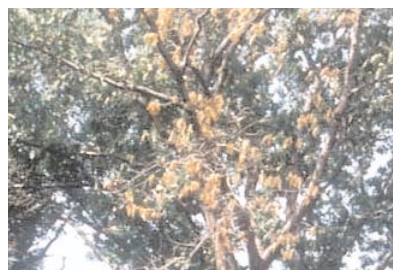
Photo courtesy of US Forest Service

Oak Wilts Geographic Range

Oak Wilt has become a serious disease throughout much of the south central, Midwest, and northern US. It is now reported in 21 states. In Texas, it is especially serious as it is wiping out Live Oak populations throughout the central corridor and the hill country. Minnesota has nearly 20,000 acres of active Oak Wilt. It is also especially severe in Wisconsin, Illinois, Michigan, Iowa, Kansas and Missouri.



Live Oak
Foliar Symptoms of Oak Wilt
in Live Oak



Red Oak
Foliar Symptoms of Oak Wilt
in Red Oak

Oak Wilt

Technical Description

Different Types of Oaks Die Differently

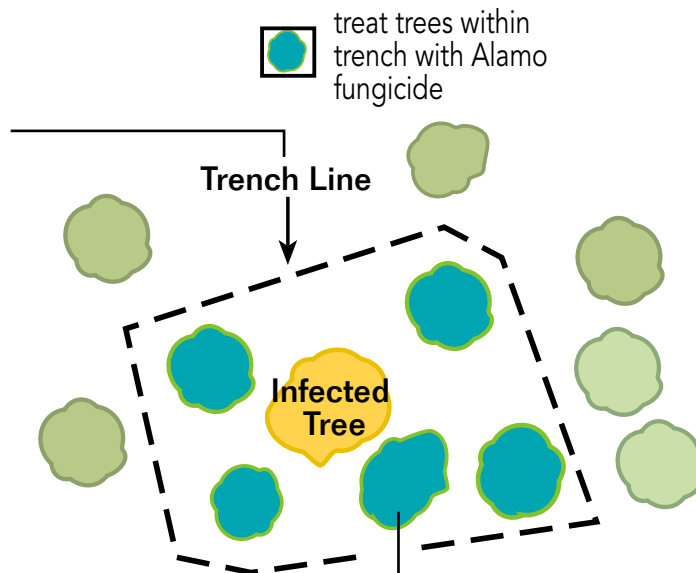
Members of the **Red Oak** family are the most susceptible to Oak Wilt. Infected trees rapidly wilt from the top of the canopy downward and trees usually die within 3-6 weeks. The response in **Live Oaks** is variable. Most trees will die quickly while a small percentage will recover. It generally takes from 1 to 6 months after initial symptoms are recognized for mortality to occur. Members of the **White Oak** family are generally more tolerant to the disease. In some cases there appears to be a complete remission of symptoms. In other cases the tree declines slowly, losing a limb or two per year until the tree is no longer aesthetically pleasing. In some White Oak species such as **Bur Oak**, tree mortality can be rapid. Tree health seems to play a role in the **White Oak** family as stressed trees appear to decline more rapidly.

Progress

Research at Texas A & M, the University of Minnesota, and the US Forest Service has demonstrated the spread of Oak Wilt through root grafts can be prevented by severing roots. Research suggests using a Macro-Infusion treatment with the chemical Alamo for high valued trees adjacent to diseased trees.



One method of controlling the spread of Oak Wilt is through root graft disruption. This involves cutting roots with a trencher or rock saw



Macro- Infusion with Alamo is an effective method of protecting valuable trees that are threatened near an Oak Wilt center

Oak Wilt

Symptoms & Diagnosis

Do You Really Have Oak Wilt?

Diagnosing that the oaks in question actually have Oak Wilt is the first step in any disease control program. There are a number of oak maladies that are often confused with Oak Wilt. Review *"the issues with Oak Wilt"* pages to insure you are not dealing with other diseases or problems.

Each Oak Family Expresses Symptoms Differently

Each of the families of Oaks – Red, White and Live express the disease differently. However, they have one key symptom in common – leaf drop. Leaf drop is an important symptom because most other Oak maladies do not cause leaf drop. When leaf drop is combined with one or more other symptoms, Oak Wilt can be reliably identified.

Red Oak Family

Symptoms of Red Oaks with Oak Wilt include:



- Leaf drop
- Leaves that are partially brown and partially green
- Rapid progression of symptoms from top of the tree downward
- Tree death in 4 to 6 weeks
- Dark streaking under the bark (Not always present)
- Surrounding Red Oaks also wilting & dying
- Spore mats form ONLY IN THE Red Oak FAMILY. The spore mat lies underneath the bark, look for cracks

White Oak Family

Symptoms of White Oaks with Oak Wilt include:



- Leaf drop
- Leaves that are partially brown and partially green
- In some cases leaves are an olive drab color with a dry appearance
- Progression of symptoms from ends of branches inward
- Branches dying one at a time over a variable period.
- Tree death can take months or years
- Dark streaking under the bark (Not always present)

Live Oak Family (Texas)

Symptoms of Live Oaks with Oak Wilt include:



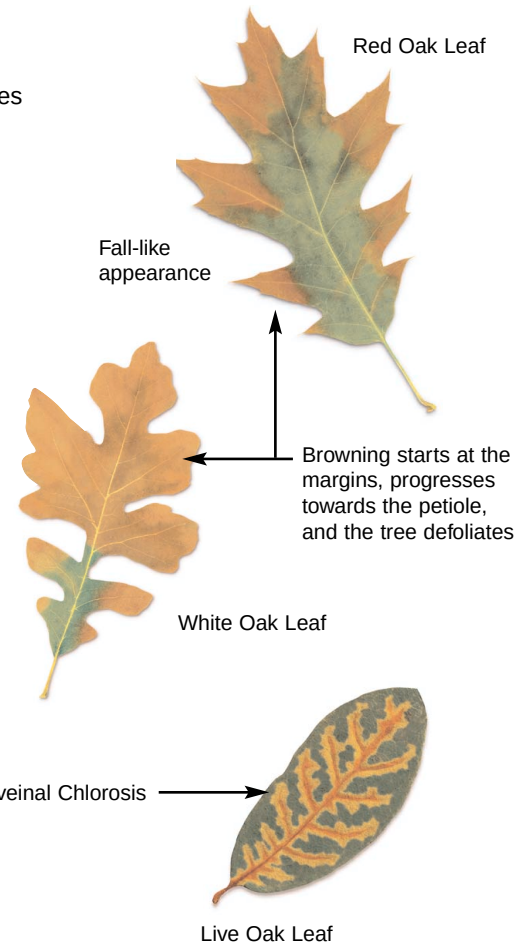
- Leaf drop
- Leaves have interveinal chlorosis
- Symptoms appear all over tree
- Tree death can take 1-6 months
- Dark streaking under the bark (Not always present)
- Surrounding Live Oaks also wilting and dying



Leaf drop is an important symptom for Oak Wilt. Most other oak maladies do not cause leaf drop



Streaking under the bark when found is a reliable confirmation of Oak Wilt. However, streaking is not always present



Oak Wilt

Symptoms & Diagnosis

How To Sample For Oak Wilt Diagnosis

Information below comes from Texas A&M University <http://plant.pathology.tamu.edu/Textlab/OakWilt.html>

Another method of diagnosing Oak Wilt is to have a laboratory or university extension disease diagnostic clinic culture the causal agent to confirm it is *Ceratocystis fagacearum*. Follow these steps to do this.

An important note: A negative culture for Oak Wilt is common because the disease is difficult to isolate and sensitive to temperatures above 85 degrees Fahrenheit

How samples are taken and handled is vital to the success of a laboratory analysis. By following the steps outlined below the chance of recovery is greatly improved

- Select symptomatic limbs from trees.
- Dead limbs and those in an advanced state of decline cannot be used for isolation.
- Samples should be 1.5 to 2 inches in diameter and 6 inches long.
- Send in leaf tissue from sampled limbs. These will help to diagnose the problem if the Oak Wilt fungus is not isolated from the limb samples. Keep the two samples separate.
- Keep samples cool during sampling and shipping but do not freeze tissue.
- Ship samples in sealed plastic bags. Do not add water or wet materials to the sample.
- Ship in an ice chest with a frozen freezer block. Oak Wilt will die if exposed to temperatures over 85 degrees Fahrenheit
- Ship by bus, overnight mail, or bring in person to the laboratory. The samples should be shipped on a Monday, Tuesday or Wednesday. The samples will arrive at the laboratory so that they can be processed that week.
- Results from the isolation's will be available in 2 to 3 weeks. Reply time depends on how fast the fungus develops in culture.
- To aid in the diagnosis the following information is helpful to include with the samples:
 1. When did the problem develop?
 2. How many trees are involved?
 3. Does the problem appear to be spreading?
 4. Has anything been done over the root system of the tree? As a rule of thumb, the roots extend beyond the trunk 2.5 to 3X the distance between the trunk and the trees drip line.
 5. If trees are dying, how fast is the mortality?

Ship the samples to:

Texas - <http://plantpathology.tamu.edu/index4.html> or call. (409) 845-8032

Minnesota - http://www.na.fs.fed.us/spfo/pubs/howtos/ht_oaklab/toc.htm#intro Call 651-296-4749

Wisconsin - <http://www.plantpath.wisc.edu/pddc/Files/Clinic%20Brochure010103.pdf> Call 608-262-2863

Michigan State Pathologist, Michigan Dept of Agriculture – Laboratory Division, 1615 Harrison Rd, East Lansing, MI 48823 Call (517) 337-5091

Other Areas of the country – Contact your local extension agent

Root Graft Transmission



Live Oaks

Oak Wilt mostly travels through roots as seen in this photo of a Live Oak Wilt center in Texas

Photo courtesy of Dave Appel



Red Oaks

Oak Wilt mostly travels through roots as seen in this photo of a Red Oak Wilt center in Minnesota

Photo courtesy of US Forest Service

Oak Wilt

Issues Confused with Oak Wilt

Oak Wilt is commonly misdiagnosed. There are a number of problems that afflict oaks, unrelated to Oak Wilt. The protocol to treat these problems is different than treatment for Oak Wilt. If you determine your tree is suffering from one of these ailments, call a qualified consulting arborist for treatment recommendations.

Injury Caused by Human Activities

The most common injury to oaks caused by the activities of people fall into three primary categories. Changes in soil grade, soil compaction, and cut roots. Symptoms usually include thin crowns and die back.

Changes in Soil Grade

Roots of trees grow near the surface of the soil. These "feeder" roots are often in the top few inches of the forest floor and your yard. They absorb water, oxygen and minerals from the soil that are used in the day to day life system of the tree. When additional soil is added over the top of tree roots they are, in effect, suffocated. Added soil is often denser and more compacted than the original soil. This prevents the tree from establishing new roots. Ultimately the tree will die from this. Sometimes the decline and death can take many years. The best remedy is to remove the added soil and do a process called soil replacement therapy.

Soil Compaction

Forest soils are loose and fluffy allowing roots to grow and replace themselves easily. Gas and water exchanges freely which allows a tree to grow optimally. Soil compaction results from soil particles being pressed together. This interrupts the free flow of moisture and gas exchange, and inhibits root growth. Trees that are growing in these conditions become inefficient and are less able to respire. They often begin to slowly decline as they use more energy than they are able to manufacture. If they have low energy reserves when the compaction takes place, they usually will die within a couple of years. Trees with higher energy reserves can live for as long as 10 years. This of course all depends on the degree of compaction. To help trees growing in these conditions you must replace the soil and give the tree new soil to grow in that is not compacted. This is usually done with a large drill which removes cores of soil and replaces the soil. We call the process soil replacement therapy.

Cut Roots

Roots get cut for various reasons. Situations include utility replacement, home construction, sidewalk repair, sprinkler installation, and other reasons. Because most tree roots grow in the top 12 inches of the soil, the cut does not have to be deep to injure the tree. Severe root loss will show up as dehydration – which happens quickly as the tree dries out and wilts. Less severe root loss will show up as crown dieback in future years. If roots on your tree have been cut, there is little that can be done. Make sure the soil is not compacted (see above) so the roots can grow back. Water more often during dry spells.

Boring Insects

Boring Insects can cause a great deal of damage to a tree very quickly as they consume the trees water and food conducting tissue. Healthy trees have natural defenses that are very effective in preventing borer attacks, thus if borers are attacking your tree it has been weakened by another situation. (Note: There are a few highly aggressive boring insects including the Emerald ash borer and the Asian longhorn beetle, which are both introduced from Asia. However these are rare and isolated to very specific areas of the country). The symptoms of borer attacks is dieback that starts in the top of the tree. The leaf symptoms are different than Oak Wilt symptoms in that the leaves remain stuck to the branches, while the leaves when associated with Oak Wilt fall off the tree. Check with a highly trained arborist to set up a treatment protocol and diagnosis to uncover the cause of why your tree is weak enough to be attacked by borers.



Urban yards often have soil compaction that slowly causes the trees that live there to be weak and vulnerable to environmental changes such as drought. They are often taken advantage of by opportunistic diseases and insects.



Adding soil under a tree will bury the roots. This will cause a reduction in water and gas exchange. This will cause trees to decline and die.



Roots are often cut when utilities or sprinkler systems are installed. This can cause serious problems which show up as dieback or tree death.



Boring insects invade trees that have been weakened by other factors. Notice that the dead and dying leaves are still attached to the tree. They will also attack trees infected with Oak Wilt.

Oak Wilt

Issues Confused with Oak Wilt

Hypoxylon Canker

Hypoxylon Canker has very characteristic growths on the trunk and large branches. Hypoxylon Canker is a fungal disease that often attacks trees that are weakened. Healthy trees have natural defenses that are very effective in preventing Hypoxylon Canker, thus if your tree is being infected, it has been weakened by another situation. A symptom of Hypoxylon Canker is dieback that starts in the top of the tree. Weeping areas will develop on the trunk and branches (see photo to the right). The leaf symptoms are different than oak wilt symptoms in that the leaves remain stuck to the branches while the leaves when associated with oak wilt, fall off the tree. Check with a highly trained arborist to set up a treatment protocol and diagnosis to uncover the cause of why your tree is weak enough to be infected with Hypoxylon Canker.



Photo courtesy of
US Forest Service

Hypoxylon canker has very characteristic growths on the trunk of the tree as shown in this photograph. However, it can invade a tree after it has been killed by Oak Wilt.

Herbicide Injury

Broadleaf herbicides are designed to kill broadleaf plants. Trees are large broadleaf plants and can be injured by these chemicals that are commonly used to kill weeds in turf. Herbicides that cause the most damage to trees are usually types that move in the soil and are taken up by tree roots. Dicamba which is a common ingredient in many herbicides specifically says on the label to stay away from trees and shrubs. Excessive weeds in lawns are often a sign of thin grass and compacted soil. Mowing high (3 inches), and watering deeply and infrequently, and over-seeding with new and improved grass cultivars will often make a lawn healthier with fewer weeds.



Photo courtesy of
Bartlett Tree Experts

Bacterial Leaf Scorch

Bacterial Leaf Scorch is a disease that is becoming more prevalent. It causes the slow death and decline of infected trees. Leaves of infected trees usually have a scorched appearance with dieback starting at the edges and moving inwards. The dead leaves of infected trees will cling to the branches as compared to Oak wilt, where the leaves fall. Application of Cambistat was shown in a study to suppress Bacterial Leaf Scorch for three years in Oak.

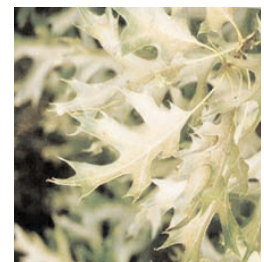
Bacterial leaf scorch exhibits symptoms on leaves as shown. It is becoming more common in recent years.



The symptoms of Chlorosis include a yellowing of the foliage.

Chlorosis

Chlorosis is a tree problem that results from a tree being unable to make chlorophyll. The leaves of these trees are often yellow and sometimes have dieback starting at the veins and moving outward. This problem is usually associated with trees whose root systems are not well developed. Other contributing factors include high pH soils or soil compaction. Treatment is usually a multi-step process depending on the situation. Adding iron directly to the vascular system using Macro-infusion will provide a short-term (3 years) solution in 90% of the cases. Combining this with materials that stimulate root growth such as Cambistat and soil replacement therapy where soils are compacted will provide a longer-term solution.



Spider mites cause injury as they suck plant juices out of the leaves. This creates a bronze cast on the leaf.

Spider Mites

Spider mites are small insect-like bugs that feed on plant juices. They cause small feeding injuries that, when present in high numbers, create a bronze look to the tree. Effective treatment involves spraying the tree with a material especially designed for spider mites, that does not harm other insects. Ask your arborist for the exact protocol. Trunk injections are a poor solution as they cause unnecessary injury.

Oak Wilt

Issues Confused with Oak Wilt

Oak Anthracnose

Oak Anthracnose is a fungal disease that affects newly forming leaves in the spring. It causes a brownish appearance on the tree and in severe cases will cause the entire tree to turn brown. It is rarely fatal and usually occurs as the leaves emerge during cool and wet springs. Healthy Oaks can easily withstand this disease and can replace the infected leaves within 1 month. Less healthy trees can be further weakened by this disease. In mild cases no treatment is required, however in weakened trees that become severely infected, the disease can become chronic. Treatment will involve 3 timed sprays in the following season to prevent the disease from establishing itself. Treatment is only preventive. Treating a tree that already has symptoms is not effective or practical.



Oak Anthracnose is a leaf fungus. It is rarely a major problem for a healthy tree.

Oak Twig Girdler and Oak Twig Pruner

These beetles cause very conspicuous damage in late summer. The leaves on large numbers of twigs and branches turn brown prematurely. These twigs and branches sometimes fall from trees in great numbers and accumulate. On close examination, the twigs have one of two kinds of damage. Twigs damaged by the twig girdler are cut as neatly as by a knife. The cut end has been gnawed almost straight across with a faint rounding and is slightly roughened by the chewing. The twig pruner causes a slightly different type of cut. The twig will be observed to have a hollowed out space at the cut end filled with sawdust (frass). The twig when split open will have a long tunnel through most of its length.



Oak twig girdlers cause clumps of leaves to fall off the tree.

Armillaria Root Rot

Armillaria Root Rot is a fungal disease that infects the roots of weakened trees. Because fungi that cause Armillaria Root Rot commonly inhabit roots, their detection is difficult unless characteristic mushrooms are produced around the base of the tree or symptoms become obvious in the crown or on the lower stem.

Crown symptoms include foliage that thins and discolors, turning yellow, then brown; branches die back; and shoot and foliar growth are reduced. On large or lightly infected trees, crown symptoms develop over a number of years until the trees die. Infected portions of the root area of the tree sometimes develop sunken cankers covered with loose bark or bark infiltrated with gum and other exudates, but most often these cankers are inconspicuous or absent. If Armillaria is present, removing the bark covering infections will expose the characteristic white mycelial mats, or the rhizomorphs that grow between the wood and the bark. Treatment of this disease is difficult in advanced cases. Fertilization is a very poor treatment as it will provide additional nutrients for the fungus to feed on.

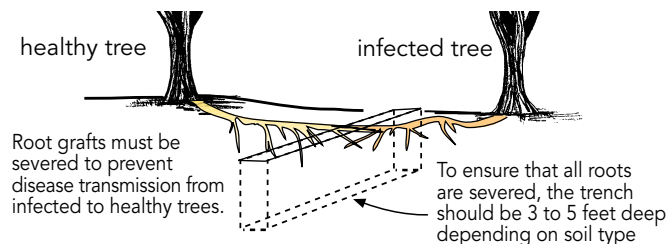


Armillaria attack the root systems of trees. Trees decline and die over a period of a few years. Mushrooms like the ones shown here growing at the base of the tree are common signs of the causal agent.

Oak Wilt

Root Graft Disruption

Root graft disruption is an important means of controlling Oak Wilt. A combination of trenching and treating with Macro-Infusion of Alamo will save more trees than trenching alone. The most commonly used equipment for trenching is a trenching machine, rock saw, or a vibratory plow.



Success Is Variable

Success with breaking root grafts has been variable and is not always possible because of factors present on the site. These factors include utilities, slopes, and objects that block the equipment from cutting all the roots, such as: slab house foundations, rocks, or other trees. Also, because the depth of the trenching equipment can be limited, you can have situations where the roots are growing deeper than the trenching equipment can cut. This is most often the case in porous soils such as sand or rock aggregate. When disrupting roots in these soils, as low as 60% success has been reported. Other less porous soils show much higher success with trenching to disrupt root grafts. This is because roots will not grow deeper than a ready supply of oxygen is available.



This is a vibratory plow which is commonly used in sand soils.

This Rock saw is used in Texas because of the rocky soils.



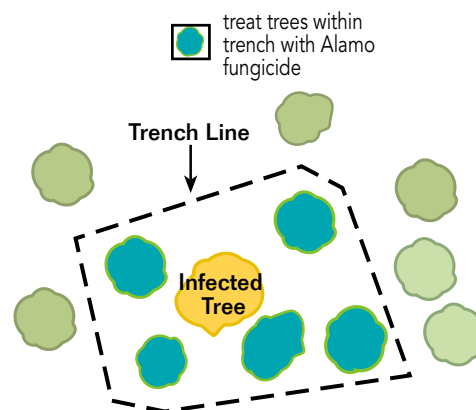
Photo courtesy of Dave Appel

The Purpose of Trenching

The purpose of trenching is to disrupt the root grafts that connect diseased trees to healthy trees. Of course it is difficult to know exactly where the Oak Wilt fungus lies within the vascular system of a tree, so a conservative approach must be used. Trees that show symptoms of oak wilt must be physically isolated from nearby symptom free trees. If the trench is in place before the fungus has spread past the trench then the adjacent trees will not be infected through root graft. If the disease has already traveled through the root system past the place where the trench was dug then the disease has not been contained.

Other Information

Trenches are typically installed 50 – 100 feet from the infected tree to insure that the disease has not entered the roots being cut. This often means cutting outside trees that are not showing symptoms. These trees not showing symptoms that are close to the infected tree are the best candidates for Alamo macro-infusion. If using a trenching method that removes the soil from the trench, it can be backfilled immediately. Research shows that root grafts will generally reform after 4 – 5 years. However, both trees must be actively growing for roots to regraft. Thus, trees that died from Oak Wilt will not regraft to healthy trees.



Oak Wilt

Protecting & Saving Oaks with Alamo®

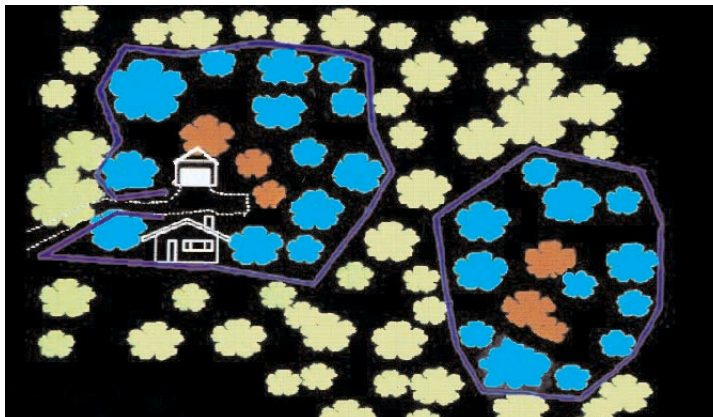
The Purpose of Alamo Macro-Infusion

Alamo Macro-infusion is an effective tool for protecting and saving oaks threatened by oak wilt. It is the only process recommended by either the US Forest Service or the Texas Forest Service. The purpose of Alamo Macro – infusion is to evenly and completely cover the internal vascular system of the tree with enough chemical to keep the disease out. Since the Oak wilt fungus can stay alive in the root system of surrounding infected trees for 4 years, it is necessary to retreat oaks after 2 or 3 seasons, depending on the oak variety (See individual tree information below). Each variety of Oak reacts to the Oak wilt fungus in unique ways, thus it is important to understand the protocols for your oak species as specified below.

Each of the 3 Oak Families Require a Different Treatment Approach

Red Oak Family

- Alamo macro-infusion should only be used as a preventive treatment for trees in the Red Oak family. If a Red Oak is showing symptoms of Oak Wilt a therapeutic treatment of Alamo will not save the tree.
- Red Oaks that should be treated are those that are not showing symptoms of Oak Wilt but are within root graft distance to a diseased tree. (100 feet)
- Alamo does not provide a barrier from neighboring untreated oaks. The disease will pass through the treated oak and continue to infect other oaks that are root grafted to the treated tree.
- When treatment with Alamo is combined with trenching to disrupt root grafts. Only treat Red Oaks inside the trench line that are not yet showing symptoms.
- Treat Red Oaks again in 2 years after the first treatment. Because the Oak Wilt fungus can remain alive in the roots for up to 4 years, this is recommended to prevent re-infection. No additional treatments should be needed.
- Treat with 10 ml of Alamo per diameter inch and dilute each 10 ml of Alamo in up to 1 quart of water. The label allows for up to 20 ml per inch diameter for trees over 25" diameter



When combining Macro infusion with trenching red or Live Oaks, treat the trees inside the trench that are not symptomatic. These are colored in blue.



Alamo Macro infusion will save trees when used in conjunction with an appropriate protocol

For detailed step by step instructions on how to Macro-infuse Oaks, see [Performing Macro-Infusion on Oaks](#).



Only treat Red Oaks that are not showing disease symptoms within 100 feet of diseased trees.

Do not treat oaks in the Red Oak family that are showing symptoms of Oak Wilt.

Photo courtesy of US Forest Service

Oak Wilt

Protecting & Saving Oaks with Alamo®

White Oak family

- Macro-infusion with Alamo should only be performed therapeutically in the white oak family.
- White Oaks have a greater natural tolerance to the Oak Wilt disease and trees may persist with the disease for many years, losing only a branch or two per year until they are no longer aesthetically pleasing.
- White Oaks at risk for root graft infection do not need to be treated preventively with macro-infusion of Alamo. Only infected trees with up to about 30% canopy loss should be treated. Sometimes saving heavily infected trees is not the best option. A second treatment in some cases (approximately 15% of cases) will be needed if symptoms reappear. Retreatment is only necessary if symptoms reoccur in subsequent years.
- Treat with 10 ml of Alamo per diameter inch and dilute each 10 ml of Alamo in up to 1 quart of water. The label allows up to 20 ml per inch DBH for trees over 25" diameter.



For detailed step by step instructions on how to Macro-infuse Oaks, see Performing Macro Infusion on Oaks.

Live Oaks

- Live Oaks are most effectively macro-infused preventively before they are showing symptoms. However some success has been reported in saving infected oaks in the early stages.
- Live Oaks that should be treated are those that are within root graft distance to a diseased tree. (within 200ft)
- Therapeutic treatments are less effective, but treating with Alamo will save some trees that would otherwise be lost. If therapeutic treatments are attempted, greater success will be had with trees with less infection. Generally therapeutic treatments are attempted on trees with less than about 20% crown loss.
- Higher success has been reported in saving diseased Live Oaks when a second treatment is performed in the early spring following the initial treatment.
- Treat with 10 ml of Alamo per diameter inch and dilute each 10 ml of Alamo in up to 1 liter of water. The label allows up to 20 ml per inch DBH for trees over 25" diameter.
- Alamo does not provide a barrier from neighboring untreated oaks. The disease will pass through the treated oak and continue to infect other oaks that are root grafted to the treated tree.
- When treatment with Alamo is combined with trenching to disrupt root grafts. Only treat Live Oaks inside the trench line that are not yet showing symptoms.
- Treat Live Oaks again in 2 - 3 years after the first treatment. Because the Oak Wilt fungus can remain alive in the roots for up to 4 years, this is recommended to prevent re-infection. No other treatments should be needed.



Treat White Oak family trees only if they are currently diseased. Alamo Macro-infusion success rate is very high in White Oaks that are already infected – over 99%



Treat Live Oaks that are within 200 feet of dying oaks. Already infected Live Oaks can be saved with Alamo, however, success will be less than 50% and a second treatment the following spring is recommended to increase success rate.

Photo courtesy of Dave Appel

Oak Wilt

Performing Macro-Infusion™

Macro-infusion is 93% successful in protecting non-diseased **Red** and **Live Oaks** that are root grafted to diseased trees. Already diseased Red Oaks cannot be saved. Diseased **Live Oaks** can be saved, but it is difficult. Treating diseased White Oaks has a very high success rate – over 98%. Following the protocols is crucial to your success.

Even and complete coverage is critical to success

The purpose of Macro-infusion in Oaks is the complete and even coverage of all the water conducting tissue in the tree in order to prevent the Oak Wilt fungus from colonizing the tree. Infusing into the root flares is critical for even and complete distribution. The tissue in the root flares allows for sideways movement of the chemical as it is infused. Trunk tissue on the other hand is hard, rigid, and highly compartmentalized. Infusion into trunk tissue will provide very limited sideways movement of the Alamo solution and will result in small portions of the crown receiving a large dose of Alamo with other areas receiving nothing. Having sufficient quantities of solution is critical. Micro-injections with Alamo have not been found to be effective, as they do not contain sufficient volume to get even and complete coverage.



Infusing into the root flares is critical to achieve even and complete distribution of the Alamo solution throughout the crown of the tree.



Every aspect of Macro-infusion is designed to get even and complete coverage of the Oaks water conducting tissue with the Alamo solution.

Step 1 - Inspect the tree

If you are treating a **Red Oak**, make sure it is not infected with Oak Wilt. Fully scan the crown to make sure there are no symptoms. If the tree is diseased – DO NOT TREAT. **Red Oaks** cannot be saved once they are showing symptoms. Live Oaks have been saved when only a small portion of their crown is infected. However treating an infected **live Oak** has a high risk of failure. Infected **White Oaks** are easily saved with Alamo macro-infusion, success rate is over 99%.

Measure the tree and determine your dosage. Oaks require 10 ml of Alamo per inch DBH. (Diameter breast height). Each 10 mls of Alamo is diluted in 1 quart of water. Refer to the Alamo dosage sheet.

Large trees require increased amounts of chemical to achieve complete distribution. The label allows up to 20 mls of Alamo per inch DBH and we recommend you use this rate for large specimens over 25 inches DBH.

Look for root rot or significant decay in the root collar area - if present do not treat. Drilling holes into trees with active root rot fungi will spread the disease



Equipment

Rainbow provides a complete set of equipment for Macro-Infusion.

Connector tees
3 per kit

Infusion tees
Specially designed with side outlet holes to put the solution directly in the xylem. Use one tee for every 1-1/2" DBH of tree.
50 per kit

Harness tubing
To connect trees together.
110 feet per kit

High helix drill bits
Are critical for fast uptake. They are sharpened all the way down the shank, providing a clean cut.. Change bits every five trees.
2 bits per kit

Oak Wilt

Performing Macro-Infusion™

Step 2 - Excavate the root flares (if necessary)

- Use a shovel and trowel to remove sod and soil without damage to the tree
- Thoroughly brush soil from root flares with a hand broom
- Infusion sites should be 8-10 inches below the top of the root flare
- Soil left on the root flare can dull the bit and plug the xylem
- If sod is carefully removed it can facilitate fast cleanup



Remove all soil from root flares and brush them off. Drilling into a dirty flare will dull your bit and push dirt into the hole – slowing down the uptake.



Drill a series of small one inch deep holes around the tree at the root flares.

Step 3 - Drilling the holes

- Use a sharp, high helix drill bit (change every 5 trees)
- Drill perpendicular to the surface of the flare
- Drill one inch past the bark
- Drill at slow speeds, and do not excessively spin the bit in the hole
- Use 1 to 1-1/2 infusion sites (in the root flare) per diameter inch (measured at breast height)
- Place at least one infusion site on each root flare

Do not place infusion sites into or below dead tissue
Do not drill into deep valleys or sunken areas

Step 4 - Inserting the tees

- The current year xylem are the only vessels that will take up the solution. Make sure your tee is properly positioned to deliver the Alamo there
- Check each tee to be sure it is not plugged and replace any that are badly damaged
- Firmly insert tees by hand and very lightly tap each tee to set it
- Attach tubing from solution reservoir to feed into the harness in 2 locations. These 2 sites should be on opposite sides of tree

Plugged tees will prevent that portion of the xylem from receiving chemical
The only vascular tissue that conducts water is the current year's xylem



Insert infusion tees and hook up tubing harness to pump.



Make sure the Macro - infusion tee is delivering solution to the current years xylem. This is the only water conducting tissue that will take up solution.



Trowel

An ergonomic trowel makes digging easier for you and the tree- Less strain on your wrist. Works with a pulling motion, less chance of scaring the tree.



Use a sharp HIGH HELIX drill bit for fastest uptake.
Replace drill bit every 5 trees.

Oak Wilt

Performing Macro-Infusion™

Step 5 - Starting the Infusion

- Pull out 2 tees on opposite sides of the tree
- Pressurize the tank and bleed the air out of the line
- With all air out of harness, re-insert the 2 tees and check for leaks
- Adjust the pressure to 15-20 psi
- Lightly tap any leaking tees
- Increasing the pressure will not make the infusion go faster
- If a tee persists in leaking, drill a new hole.
- Use a very small hammer to tap leaking tees - this helps prevent driving them in too far



Macro Infusion uptake in oaks should take less than 2 hours – 90% of the time. Call Rainbow for technical support if uptake is consistently longer than this.

Note: Diseased Oaks will take longer to take up solution as they have plugged water-conducting tissue.

DO NOT TREAT DISEASED RED OAKS



Alamo Macro-Infusion System is the only treatment method currently recommended by the US Forest Service and the Texas Forest Service for oak wilt.

Step 6 - Mixing the Chemical

- Mix 1 Quart of water with every 10 ml of Alamo

For infusions that require a larger volume of solution than the reservoir holds, use 5 gallon buckets to measure the remaining dose and add to the reservoir.

Step 7 - During the Infusion

- Monitor tees for leaks
- Maintain pressure at 15-20 psi
- Pack other equipment such as drill, unused chemical, etc.
- Prepare other trees on site for treatment

Step 8 - Cleanup

- Disconnect tank when air is drawn into the harness
- Remove tees from the tree
- Replace soil and sod around base of tree

Do not plug the infusion holes with wax, wooden plugs, or any other substance

Macro-Infusion™

Advantage

Complete Crown Coverage with Macro-Infusion

Macro-Infusion is a large volume application of fungicide/water solution. Research shows that fungicides need a high volumes of a carrier to get complete distribution throughout trees.

Fungicide

Macro-Infusion vs Micro-Injection

	Macro-Infusion	Micro-Injection
Chemical Carrier	Water	Alcohol/Xylene
Years Between Treatment	3 years	1 year
Tree Injury	Low	High
Volume of Material	20 - 40 gallons	1-2 ounces
Distribution in Tree	Complete	Minimal
Application Time	40 - 90 minutes	30 to 40 minutes
Injectio Wounding Size	15/64"	11/64" *

*Some micro-injectors use smaller holes



Proven Fungicides

Macro-Infusion™ of Arbotect and Alamo is the treatment method recommended by universities for Oak Wilt and Dutch Elm Disease.

This includes:
Texas A&M
Texas Forest Service
University of Minnesota
Michigan State

Complete Distribution Requires Root Flare Application

The science of infusing materials into trees has evolved. The purpose of any infusion is even and complete distribution of the material in the tree. This is difficult to accomplished with trunk injection. Trunk tissue is hard and compartmentalized preventing lateral chemical movement. Root flare injection allows lateral movement of material and complete crown coverage.

The Difference between Insecticides and Fungicides

There is a substantial difference in the mode of action between an insecticide and a fungicide. Insecticides work in small quantities and their mode of action is to kill the intended target, thus micro injection of insecticides can be effective. Many fungicides are really fungistatic in nature, this means they do not kill the fungus – but merely prevent it from growing. Once the fungistat chemical is gone – the fungus will continue to grow again. Fungistatic materials need to be administered in much higher volumes, this is why Macro-Infusion protocols are designed to deliver large quantities of fungistatic solution to get significant amounts of product into the crown of the tree.

Oak Wilt

Frequently Asked Questions

How Does Oak Wilt kill an Oak?

The Oak Wilt fungus, *Ceratocystis fagacearum*, enters an oak either through a root graft or a fresh wound. Once inside the tree, the fungus grows in the water carrying vessels of the tree and spreads throughout the roots, trunk, and branches. As a mode of defense, the tree attempts to stop the spreading fungus by producing gummy substances, called tyloses. Tyloses clog the water vessels within the tree, but do not stop the fungus. The lack of water flow causes leaves to wilt rapidly and fall to the ground. So, in effect, the Oak Wilt fungus stimulates the tree to kill itself.

How is the Disease Spread?

Oak Wilt is spread in two ways; overland infections and root graft infections.

Most overland infections are initiated by fungal spores transported on the bodies of sap feeding Nitidulid beetles. The spore pads only grow beneath the bark of diseased Red Oaks. Nitidulid beetles feed on the spore pads, which are exposed when the pads form pressure pegs cracking the bark open. The contaminated beetles transport the spores to fresh wounds on healthy red and Live Oaks.

Root graft infections account for approximately 90% of the spread of the disease within an infection center. Oaks within 50-100 feet of one another often will have a common root system due to root grafting. Rarely do trees of different species graft roots. The root grafts allow the Oak Wilt fungus in a diseased oak to travel within the water carrying vessels through the root grafts into a healthy oak.

What are The Symptoms of Oak Wilt?

Symptoms of Oak Wilt can be easily confused with other Oak disorders. Make sure that the symptoms your tree is expressing are consistent with the following descriptions before concluding you have Oak Wilt. Each of the families of oaks – Red, White and Live express the disease differently. However, they have one key symptom in common – leaf drop. Leaf drop is an important symptom because most other Oak maladies do not cause leaf drop.

What Do I Need to Know About Pruning Oak Trees?

Texas and Southern United States

Avoid pruning your oak trees except in January and February. During the rest of the year, the spore carrying beetles are most active and oak wilt spore production may be present.

Central United States

Avoid pruning your oak trees during the growing season. During this time of year, the spore carrying beetles can be active and oak wilt spore production may be present.

Northern United States

Avoid pruning your oak trees from April 15 to October 15. During this time of year, the spore carrying beetles are active and oak wilt spore production may be present.



Overland infections by beetles account for a small percent of new infections

Photo courtesy of Minnesota DNR



Root graft infections cause most new Oak Wilt cases.

Photo courtesy of Minnesota DNR

Oak Wilt

Frequently Asked Questions

How do you control Oak Wilt?

There are three very effective ways to control Oak Wilt:

- Root graft disruption
- Sanitation
- Macro-infusion of Alamo fungicide.

Root Graph Disruption

Root graft connections must be cut before the diseased oaks are removed. Failure to do so can spread the disease even faster. The most common tool for root severing is a trencher, rock saw, or ripper bar. Locate utilities before beginning any underground project.

Once the infection site is isolated, removal of the diseased **Red Oaks** is crucial. Removal of diseased **Red Oaks** is very important since Oak Wilt spore pads may form beneath the bark. Picnic beetles are attracted to the scent of spore pads, which they will feed upon.

Macro-Infusion of Alamo

Red Oak Family

If possible, Red Oaks should be treated when the Oak Wilt is within 50 to 100 feet. Close monitoring of nearby oak trees is essential in identifying the Oak Wilt's presence and spread. Once showing symptoms, Red Oaks cannot be saved with Macro-Infusion. The best candidates for injection are those that are immediately threatened but are not yet showing symptoms. All Red Oaks within a trenched area should be infused unless they are showing symptoms. A follow up treatment should be performed in 2 years.

White Oak Family

Because white oaks have some ability to fend off this disease, this family of oaks can be effectively cured with macro-infusion of Alamo. A second treatment in some cases (approximately 15% of cases) will be needed if symptoms reappear. Re-treatment is only necessary if symptoms reoccur in subsequent years.

Live Oak Family (Texas)

If possible, Live oaks should be treated when the Oak Wilt is within 200 feet. Close monitoring of nearby oak trees is essential in identifying the Oak Wilt's presence and spread. It is best to Macro-infuse trees before infection, although there has been some success treating trees once they are infected. However, success diminishes rapidly the longer the treatment is withheld. The best candidates for Alamo Macro-infusion are those that are immediately threatened, but are not yet showing symptoms. All live oak trees within a trenched area should be Macro-infused unless they have lost more than 20% of their leaves. Higher success has been reported in saving diseased Live oaks when a second treatment is performed in the early spring following the first treatment.



This Oak tree has Oak Wilt. Leaf drop is a major symptom of Oak Wilt. With most other Oak ailments leaves stay on the tree after they die.



Red Oak Leaf



White Oak Leaf



Live Oak Leaf

Oak Wilt

Frequently Asked Questions

What If Pruning is Necessary During Susceptible Time Periods?

If it is ever necessary to prune your oaks during these time periods, use proper pruning techniques and paint wounds immediately, no matter what the size, with a tree wound paint. This will help prevent the beetles from transferring the fungal spores to the wound. Wound paint should also be used when any injury, such as storm or lawnmower damage, occurs to oaks during this time period.

Do I Have To Remove a Tree Killed By Oak Wilt?

Red Oaks are the main concern for removal. On **Red Oaks**, the Oak Wilt spore producing fungal mats may form, these are responsible for the long distance spread of Oak Wilt. Therefore, once a **Red Oak** becomes infected, the tree should be removed immediately. The wood must then be chipped, burned, or buried. On **live** and **White Oaks**, fungal mats do not form so immediate removal is not necessary.

Oaks that have been dead for more than one year do not produce spore pads. For this reason, removal of the trees is unnecessary unless they present a hazardous situation.

Is It Safe To Mulch With or Burn The Wood From Diseased Trees?

Chipping or shredding the wood from infected trees to use as mulch is an acceptable method of utilizing the wood. The Oak Wilt fungus has certain moisture and temperature requirements in order to live. Chipping or shredding allows the wood to dry out quickly, thereby killing the fungus.

Smoke from burning infected wood will not spread Oak Wilt. In fact, burning diseased logs actually kills the Oak Wilt fungus. However, diseased Red Oak firewood should not be stored on a homesite because the wood could contain fungal spores or insects which carry the spores and have the potential to infect healthy trees nearby.

Can I Use Infected Trees for Firewood?

Firewood from infected **Red Oak** trees can be used if older than 1 year, or certain precautions are taken. If possible, find out where the firewood you are buying came from. Be extremely cautious of any oak firewood coming from an infected area or area you are unsure of. When buying oak, make every effort to buy only properly seasoned (dried) wood. Dry wood does not meet the specific moisture requirements of the Oak Wilt fungus. You can be sure that the wood is properly seasoned if the ends of the logs are cracking and/or the bark readily peels off the wood.

It is recommended to store newly cut **Red Oak** firewood under a sheet of clear plastic and tightly seal the edges of the plastic with soil or bricks. Doing so will prevent any spore-carrying beetles from escaping. It is important to use clear plastic, as black plastic will reveal any escape holes to the beetles.



If pruning during the spring is necessary, or storms have caused injury, immediately cover the wound with a tree wound paint.



Using diseased oak wood for mulch is safe. Chipping or shredding allows the wood to dry out which kills the fungus.